PROJECT GALILEO - *the Jupiter Mission*

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Abstract

Project Galileo made a triumphant arrival at Jupiter on December 7, 1995. Galileo Galilei discovered the large moons of Jupiter while observing Jupiter with his newly fashioned telescope from Padova in January 1610. The parallels between this extraordinary man and the extraordinary Project named in his honor are remarkable. Each overcame great difficulties to ultimately succeed.

The Galileo Atmospheric Entry Probe became the first object to penetrate and directly measure Jupiter's atmosphere. The Orbiter Mothership became the first spacecraft to orbit Jupiter. Galileo Galilei discovered Jupiter has moons and his namesake became the first artificial moon of Jupiter. He was first to use a telescope to study Jupiter. His namesake is first to bring telescopes extremely close to the moons he discovered.

The Galileo Atmospheric Probe measured Jupiter with seven scientific instruments and relayed the data to the Orbiter for 58 minutes reaching a Pressure depth of 23 bars far surpassing the mission requirement of 10 bars. The Probe survived an entry speed of over 170,000 km/hr, 228 g's peak deceleration, and stagnation point temperatures of 25,000 deg F. A great wealth of scientific data was obtained. Preliminary findings are published. These only direct measurements of Jupiter's atmosphere will be a vital component of planetary research for decades.

The Galileo Orbiter is arguably the most capable planetary spacecraft ever built. It is the only dual-spin planetary spacecraft. One section spins continuously to provide stability and the sweeping motion that allows the Fields and Particles instruments to measure in all directions. The other section--the despun section--provides a precisely controlled three-axis platform for the telescopic instruments. The now fully demonstrated observational capabilities of this spacecraft in Jupiter orbit are absolutely superb for both the Fields and Particles instruments and the remote sensing instruments.

An hour after the Probe Relay the Orbiter burned its main 400 N engine for 49 minutes to achieve an essentially perfect first orbit, of Jupiter seven months long. During its primary mission the Orbiter will make eleven orbits of Jupiter with a very close flyby of one of the Galilean moons on every orbit except one. Each flyby produces the gravity-assist to the Orbiter to achieve the next desired

orbit leading to the next moon flyby one revolution later. With these flybys at typically hundreds of times closer than Voyager achieved in 1979, Project Galileo bootstraps its Orbiter around the Jupiter System studying the atmosphere, the magnetosphere, and the moons of the planet that contains twice the mass of all the other planets in our solar system combined.

And, like for Galileo Galilei, the obstacles were momentous. The evolving Space Transportation System development and then finally the Challenger accident required five major replans of the journey to Jupiter. Ultimately, Project Galileo was constrained to use the flight-proven 2-stage Inertial Upper Stage (IUS) in the Space Shuttle, IUS had only the capability to send Galileo to Venus or Mars. The mission was saved when the Galileo trajectory designers applied the Jupiter orbital gravity-assist design techniques to the interplanetary transfer and invented the trajectory Galileo actually flew--first to Venus and then twice back to Earth to build the heliocentric energy to reach Jupiter.

The October 18, 1989 launch by Space Shuttle Atlantis (STS-34) was flawless and the flight to Venus and back past Earth was excellent. Then in April 1991 the High-Gain Antenna failed to deploy, For the next two years everything possible was done to get the HGA deployed while in parallel the extraordinary mission workaround of using the 10,000 times weaker Low Gain Antenna was conceptually developed. Galileo made its planned first-ever spacecraft encounters of asteroids--Gaspra and 1 da--without the HGA or any of the envisioned work arounds. In the last three years before Jupiter arrival, the Project did a massive redesign of the flight software to provide onboard data compression, editing, and new downlink coding while the Deep Space Network (DSN) developed new receiving capabilities on Earth including state-of-the-art Full Spectrum Recorders and the arraying of several large antennas in Australia with the 70m there and also adding the 70m antenna in California to the array during the daily viewing overlap.

The new Orbital Phase Flight. Software was radioed to Galileo in May 1996 completely replacing the software in the main computer and in most of the instrument computers just in time to perform the first moon encounter with Ganymede in June. The last of the new DSN capabilities went online as planned November 1st to support the third encounter--Callisto. Galileo encountered Europa on December 19th--all the moons Galileo Galilei saw in 1610 have now been observed and/or sensed by his namesake a million times closer than he was. The remaining six encounters of the primary mission will be performed in 1997.

Project Galileo is performing superbly at Jupiter--a most fitting tribute to its namesake Galileo Galilei of Padova!

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